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An Electric Detector System for Recovering Internally Tagged Menhaden, Genus *Brevoortia*

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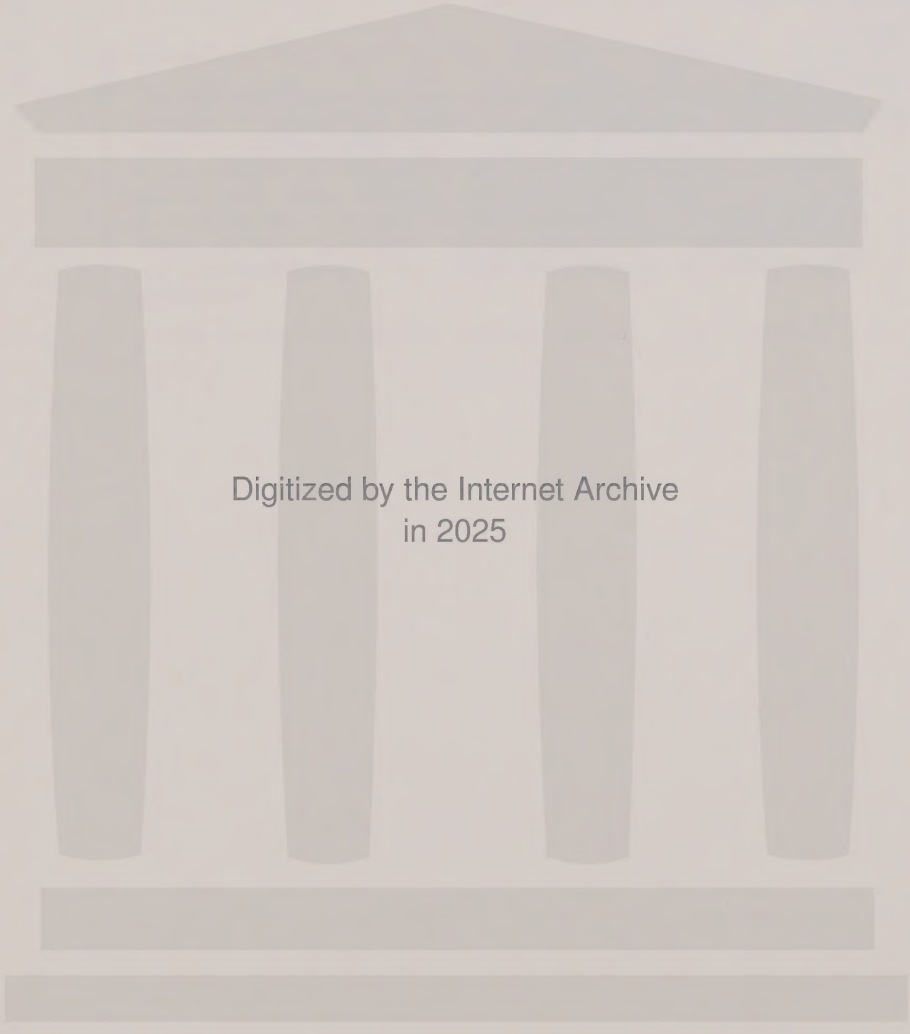

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An Electronic Detector System for Recovering Internally Tagged Menhaden, Genus *Brevoortia*

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ABSTRACT

Operation and results are described of an electronic detector-recovery system for fish with internal ferromagnetic tags. The system does not interfere with the operation of fish reduction plants. Date and location of recapture can be obtained since tagged fish are detected and recovered as they are landed. Growth rates of 3.1 and 7.2 mm per month were obtained for two menhaden out 130 and 483 days. Scale analyses supported annulus formation assumption. The best location for tag injection in adult menhaden appears to be about 13 mm above and just forward of the origin of the pelvic fin. Tag incisions were healed in 85% of the fish recaptured after 10 days.

INTRODUCTION

In most fish tagging studies the recovery of the tagged fish is desirable. Tags recovered by magnets in scrap conveyors in all menhaden reduction plants along the Atlantic and Gulf coasts of the United States are providing adequate information on migration patterns and mortality rates (Dryfoos, Cheek, and Kroger[1]). Tagged fish recoveries, however, in addition to providing the above information, permit the determination of: growth rates, validity of aging techniques, best tag injection location, and time for tag incisions to heal.

The isolation of tagged fish from millions of fish being processed has presented difficulties to many investigators. Mechanical means of catching, handling, and processing large quantities of menhaden and other industrial fish makes visual detection and recovery of marked fish impractical. Photoelectric detection of marked menhaden was unsuccessfully attempted by Reintjes (1963). Dahlgren (1936) was the first to develop a successful detector-recovery system for fish with metal body cavity tags. The system was improved by Hart and Tester (1937).

Our detector-recovery system was developed to recover menhaden tagged with a 14-mm internal ferromagnetic tag or the 1-mm Bergman-Jefferts[2] microwire tag (Jefferts, Bergman, and Fiscus, 1963). The microwire tag could not be detected at menhaden plants because of the interference of machinery. These tags, unlike our larger tags, cannot be easily distinguished from the other metal recovered on magnets. Consequently, attempts to use the microwire tag for menhaden were discontinued.

[1] Dryfoos, R. L., R. P. Cheek, and R. L. Kroger. Atlantic menhaden tagging studies, 1966-1969. Unpublished manuscript. National Marine Fisheries Service, Atlantic Estuarine Fisheries Center, Beaufort, N.C. 28516.

[2] The mention of trade names in this publication does not imply endorsement by the National Marine Fisheries Service.

DESCRIPTION OF THE SYSTEM

The electronic detector-recovery system is installed between the dock and processing plant (Fig. 1). Fish being unloaded are transferred from boat to plant by a dragline or screw conveyor. In the conveyor of a small menhaden reduction plant in Beaufort, N.C., we have installed a trap door which when open allows fish to slide down a transfer chute onto a conveyor belt. The belt is made of 8 mm rubber, 41 cm wide and 8.2 m long, and runs at a rate of 2.1 m/sec through a magnetic shield which houses a detector head. The shield, 107 × 56 × 41 cm, is made of iron-nickel alloy which reduces extraneous magnetic fields that interfere with the operation of the detector. The Jefferts detector senses minute currents created by the magnetic fields of stainless steel tags, 14 × 3 × 0.5 mm, in fish. The electronic unit has a sensitivity adjustment that can be set for different sizes of magnetic tags (Fig. 1E). When a tag is detected, an audio and electrical impulse is produced. The impulse triggers an interphase unit which activates a pneumatic gate on the side of the belt conveyor system. Time delay adjustments for closing and opening the gate are built into the interphase unit (Fig. 1F). The gate is hinged to close across the belt at an angle, forcing the marked fish off the belt into a tub (Fig. 2). If the gate is not activated, unmarked fish are carried by the belt into a screw conveyor and back to the plant's conveyor system. The detector-recovery system does not interfere with the plant's operation. Since some unmarked fish are collected with the marked ones, it is necessary to recycle the collected fish individually to isolate the tagged fish. The proportion of unmarked fish that must be recycled has been considerably reduced in our two-phase electronic detector-recovery system built at a larger menhaden reduction plant. This system consists of two sequential detector-recovery operations in which the second phase thins out most of the untagged fish (Fig. 3). Since one-half of this system is used only when a tagged fish is detected, recoveries can be recycled through this half during the actual recovery operation. The double system costs less than $14,000 including conveyors, compressor, construction, and electronics; this is about twice the cost of the single system (Appendix). However, it searches nearly twice the number of fish per hour and is nearly twice as efficient in recovering tagged fish. Thus, a cost analysis favors the double system.

OPERATIONAL PROBLEMS

Several problems were encountered when we began using the electronic detector-recovery system. False detections caused by moving metal equipment and vibrations were eliminated by shielding and isolating the detector head. Small tagged fish sometimes wedge under the closing gate and unless they are quickly removed they are lost to the screw conveyor. This loss was reduced in our later detector-recovery system by changing the type of belt lacing from a thick diagonal splice to a thin horizontal splice and by using a one-piece metallic gate assembly insert. These changes permitted a close level sweep of the gate over the conveyor belt. Another problem, overloading belts or screw conveyors, and thus stopping the units, was resolved by using higher amperage fuses.

Tests indicate that the efficiency of recovering tagged fish of the single detector-recovery installation is 36% and that of the double installation is 60%. The single installation can convey all of the catch at a small processing plant or 13 tons per hour. The double installation can convey a fourth of the catch at a conventional menhaden plant or about 22 tons per hour. Most of the losses of tagged fish in our system occur after large quantities of menhaden enter our conveyor: detection occurs and the gate closes for an instant, but as the fish are about to be deflected, a pileup occurs. This often holds back the tagged fish or causes it to flip over the gate. In both instances it is not recovered. Although up to 64% of the tagged fish entering our detector installations are missed, most of the tags are eventually recovered on magnets in the plants.

The electronic detector-recovery system was to play an additional role on the Gulf coast to that on the Atlantic coast because methods of fishing are not the same. Atlantic menhaden fishermen normally return to port daily after fishing over a small geographical area, and their catch is usually processed immediately. Thus thousands of tags recovered by magnets are providing reliable data for estimating population parameters in the Atlantic. Gulf of Mexico

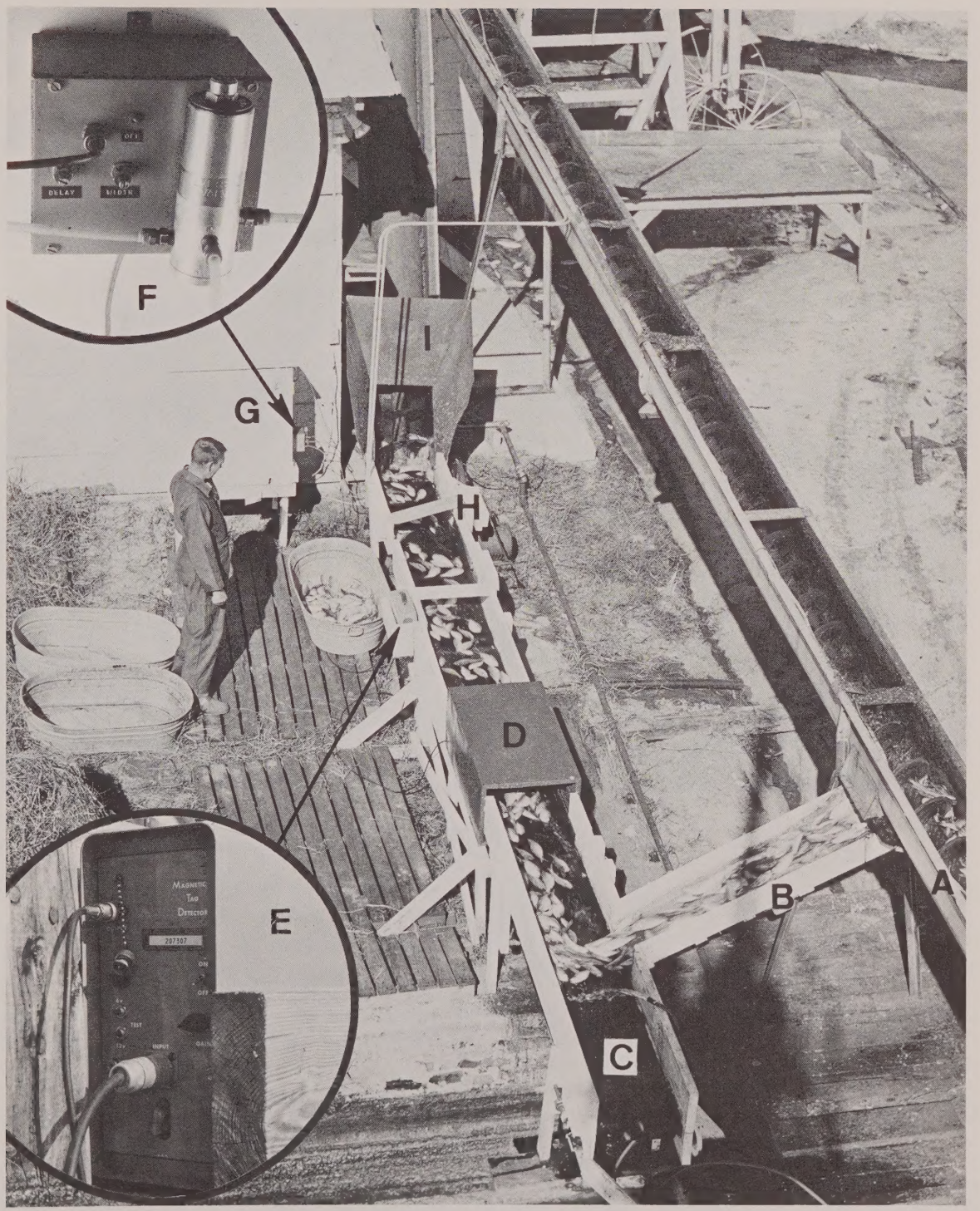

Figure 1.—Overhead view of our single electronic detector-recovery system. Shown are the plant's screw conveyor (A), transfer chute (B), belt conveyor (C), magnetic shield and detector head (D), electronic controls (E), interphase unit (F), compressor (G), gate (H), and return screw conveyor (I).

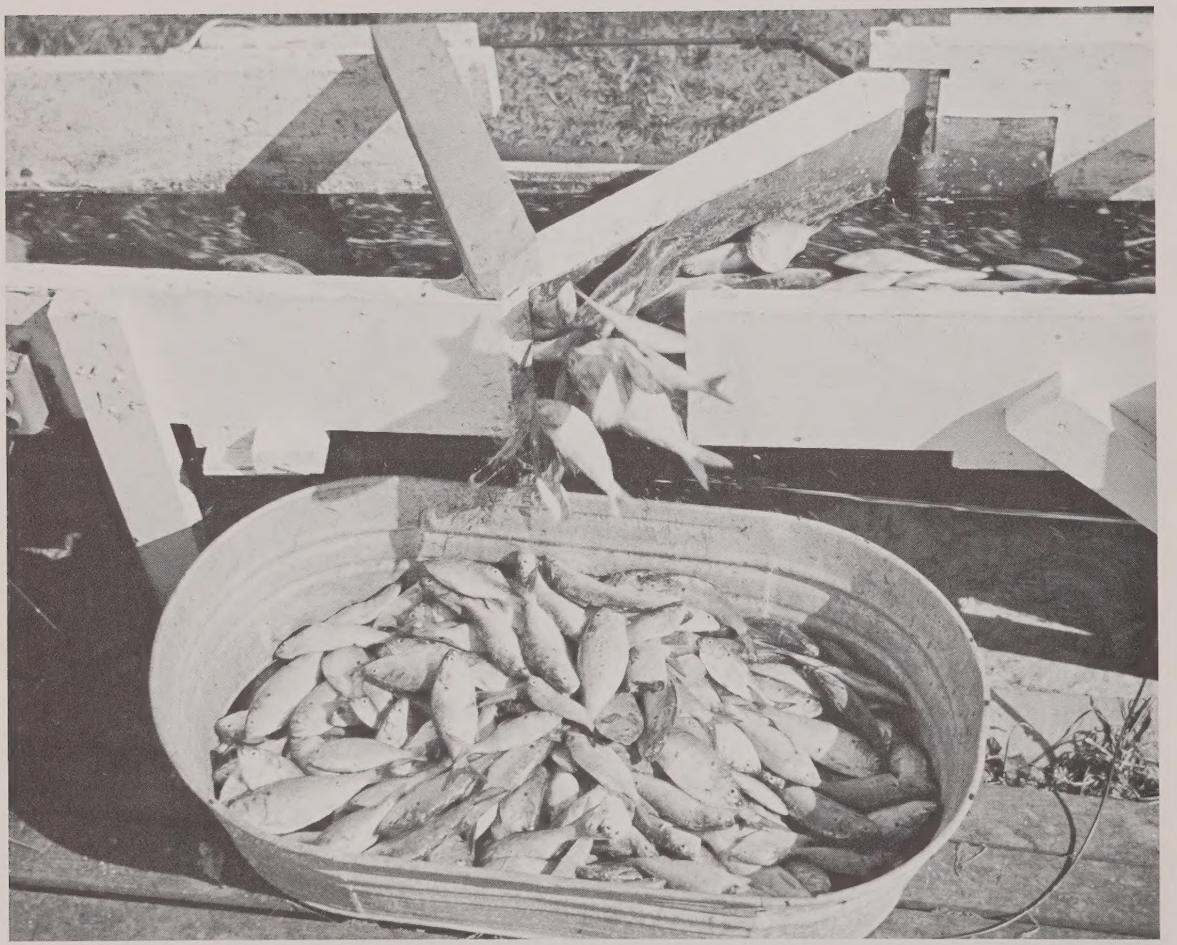

Figure 2.—Closed gate forcing fish off conveyor belt into a tub.

menhaden fishermen, however, often remain at sea for several days fishing over a wide geographical area. Hence, our electronic detector-recovery system adapted for operation aboard fishing vessels was thought to be the best means of obtaining reliable menhaden migration data in the Gulf. We have not yet resolved the technical problems of application of this system to use on vessels. The major problem is not detection of tagged fish as they are pumped aboard, but retrieval of the fish once it has been detected. Results from tags recovered by magnets in the Gulf now indicate that reliable estimates of the interchange of fish between fishing areas, growth and mortality rates, and the importance of certain estuaries in the production of menhaden may be obtained from these data. Thus, it may not now be necessary to adapt the detector-recovery system for operation aboard fishing vessels.

RECOVERIES

Since we began using the detector-recovery system in the summer of 1967, we have recaptured 231 fish. Only 34 recaptures had been out 4 months or longer and just two of these, both females, had been measured and scale sampled when released. One female, out 130 days, moved from Chesapeake Bay to North Carolina during the fall spawning migration. She grew 13 mm, 290 to 303 mm (fork length), or an average of 3.1 mm per month. The other female was released and recaptured in North Carolina waters. She had been out 483 days, from the

Figure 3.—Overhead view of double electronic detector-recovery system.

beginning of one fall through the following fall, and grew 114 mm, 183 to 297 mm or an average of 7.2 mm per month. These growth rates are considerably faster than those estimated by Richards (1968), using the Von Bertalanffy (1938) growth equation. He found that females 292 to 312 mm grew an average of 1.6 mm per month, and those 131 to 292 mm grew an average of 4.5 mm per month. Our growth rates were somewhat slower than the 7.5 mm per month for fish in Chesapeake Bay during the first 3 years of life (McHugh, 1967).

Recoveries of fish that had been scale-sampled when released can be used to validate aging techniques described by June and Roithmayr (1960). Scales from the females out 130 and 483 days revealed no and one new annulus, which supports our aging methods.

The best location for tag injection and time required for tag incisions to heal can also be determined from these recoveries. Of three locations selected for tag injection in adult menhaden, the best appears to be about 13 mm above and just forward of the origin of the pelvic fin. This was inferred from sharp decreases in recoveries after 9 days of fish tagged in the other locations. Tagging as little as 13 mm anteriorly or posteriorly of this spot can puncture the liver or spleen. Returns from two field tests designed to test these three locations verified the above conclusion. Returns were 11 to 50% better for menhaden tagged above the pelvic fin. Tag incisions were healed in 85% of the 67 fish recaptured within 10 days. The tagging scar was absent in three fish recaptured within 10 days, but it was still visible in one menhaden out 463 days.

The information obtained from these recoveries has been worthwhile and unobtainable from other techniques. However, because the cost of the detector-recovery system is greater than the magnet recovery system and because adequately precise data for population parameter estimates are being obtained from tags recovered on magnets, we are not expanding the use of the electronic detector-recovery system.

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APPENDIX

Suppliers and cost of equipment for the double detector-recovery system.

Item	Supplier	Cost
Belt conveyor components	Dillon Supply Co. Raleigh, N.C. 27602	$2,092
Screw conveyor components	P&M Steel Co. Raleigh, N.C. 27607	1,400
Assembly and construction	Local contractor	2,689
Air compressor	Sears Roebuck & Co. Greensboro, N.C. 27402	125
Electronic packages (2)	K. B. Jefferts, Ph. D. Consultant in Physics Summit, N.J. 07901	2,400
Detector heads (2)	K. B. Jefferts, Ph. D. Consultant in Physics Summit, N.J. 07901	1,000
Magnetic shields (2)	K. B. Jefferts, Ph. D. Consultant in Physics Summit, N.J. 07901	3,400
Interphase units (2)	K. B. Jefferts, Ph. D. Consultant in Physics Summit, N.J. 07901	600
Total		$13,706

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1. Predation by sculpins on fall chinook salmon, *Oncorhynchus tshawytscha*, fry of hatchery origin. By Benjamin G. Patten. February 1971, iii + 14 pp., 6 figs., 9 tables.

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7. Calico scallops of the Southeastern United States, 1959-69. By Robert Cummins, Jr. June 1971, iii + 22 pp., 23 figs., 3 tables.

8. Fur Seal Investigations, 1969. By NMFS, Marine Mammal Biological Laboratory. August 1971, 82 pp., 20 figs., 44 tables, 23 appendix A tables, 10 appendix B tables.

9. Analysis of the operations of seven Hawaiian skipjack tuna fishing vessels, June-August 1967. By Richard N. Uchida and Ray F. Sumida. March 1971, v + 25 pp., 14 figs., 21 tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 - 35 cents.

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